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China's Air Quality Dilemma

Reconciling Economic Growth With Environmental Protection

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BEFORE 2008, CONCENTRATIONS OF AIR POLLUTANTS in the city of Beijing, China, site of the 2008 Olympic Games, far exceeded acceptable standards, which caused serious concerns in the international community about the health and performance of Olympic athletes. To ensure acceptable air quality during the Olympics (held from August 8-24) and the Paralympics (held from September 6-16), the Chinese government launched a series of aggressive measures to reduce pollutant emissions.[1-3] To reduce industrial emissions, the operations of combustion facilities were restricted in smelters, cement plants, power plants, nonattainment boilers, and construction and petro-chemical industries. To reduce traffic emissions, certain vehicles and trucks were banned, 70% of government-owned vehicles were kept off the streets, and other vehicles could travel through the city only on alternating days.[3]

In this issue of *JAMA*, in a study of the relationship between air pollutants and biomarkers of inflammation and thrombosis in 125 medical students, before, during, and after the Olympics, Rich et al[4] report substantial reductions in the mean concentration of sulfur dioxide (–60%), carbon monoxide (–48%), nitrogen dioxide (–43%), elemental carbon (–36%), fine particles (particulate matter ≤2.5 μm in aerodynamic diameter [$PM_{2.5}$]; –27%), ozone (–22%), and sulfate (–13%). These changes in air quality were accompanied by statistically significant improvements in biomarkers related to platelet adhesion and activation including a 34.0% decrease in P-selectin (sCD62P) and a 13.1% decrease in von Willebrand factor during the period of the Olympics that returned toward baseline after the air pollution controls were removed.

The study by Rich et al[4] is compelling for the following reasons. First, confounding by long-term trends in air pollution and health, one of the main threats to validity in evaluating the public health consequences of long-term public health actions (eg, smoking bans, lowering national ambient air quality standards), is unlikely to bias the results of this study. This is because the air pollution levels were substantially reduced only for the 2 months that the 2008 Olympic games were taking place but then returned to their original levels. Second, these multiple actions to reduce air pollution provided a unique opportunity for investigating the health consequences of drastic and immediate changes in the air pollution mixture "as a whole" in addition to estimating health risks associated with exposure to individual pollutants.[5] Third, in addition to better understanding the toxic effects of the air pollution mixture, short-term intervention studies like this one can advance the understanding of potential biological mechanisms of adverse effects of air pollution.

See also p 2068.

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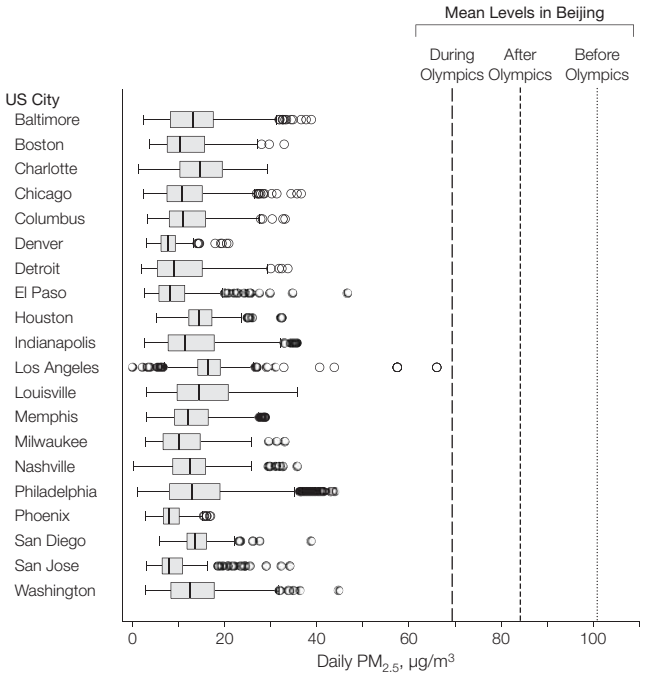
Following the general conceptual model reviewed in a recent American Heart Association Scientific Statement,[6] this study provides evidence supporting the hypothesis that exposure to higher levels of air pollution leads to a prothrombotic response, as indicated by changes in markers related to platelet adhesion and activation. The result that sCD62P improved during the Olympics and reverted after the Olympics is particularly interesting and provides stronger evidence of a possible causal link than simple cross-sectional comparisons. On the other hand, not all of the physiological pathways assessed in this study showed a response to the changing levels of air pollution. Only limited and relatively insensitive biomarkers of inflammation were measured in this study. For example, it is not surprising that C-reactive protein (CRP), as measured in this study, showed no association because the assay was unable to detect the typical low levels of CRP present in young healthy study participants. In addition, there was no evidence of an association between air pollution and changes in blood pressure. This finding may indicate that air pollution does not affect the hemodynamic response of young healthy adults or that the specific air pollution mixture in Beijing did not have an effect on this system.

This study also brings new data and evidence regarding air pollution and its health effects in one of the most rapidly developing and polluted cities in the world with a complex political and economic landscape. Nearly two-thirds of the estimated 800 000 deaths and 4.6 million lost years of healthy life worldwide caused by exposure to urban air pollution in 2000 occurred in the developing countries of Asia,[3] including China. Beijing is among the most polluted cities in the world. The average annual $PM_{2.5}$ concentration in Beijing in the last 2 years (2010 and 2011) has reached 100 μg/m^3, which is nearly 8 times higher than the proposed annual US ambient air quality standard of 15 μg/m^3 and 10 times higher than the World Health Organization guidelines of 10 μg/m^3. Data from the National Air Pollution Monitoring Network supported by the Environmental Protection Agency[7] indicate that the ambient levels of $PM_{2.5}$ in 20 large US cities during the same period studied by Rich et al[4] (June 2, 2008, to October 31, 2008) were substantially lower than in Beijing during the Olympic Games, when emissions were maximally restricted (FIGURE).

An issue of concern to environmentalists is that ambient levels of $PM_{2.5}$ make up much of the pollution in the city, but $PM_{2.5}$ levels are not included in the air quality ratings issued by the Chinese government. Chinese air quality ratings consider only PM_{10} and define "blue sky" days as days with ambient PM_{10} levels less than 150 μg/m^3. Under current guidelines, blue sky days can have PM_{10} levels that are 2½ times higher than the World Health Organization (WHO) guidelines, which has a daily 24-hour standard of 50 μg/m^3.[8]

Beijing officials have reported that the number of blue sky days has increased yearly from 100 in 1998 to 246 in 2007.

Figure. Daily Ambient $PM_{2.5}$ Levels in 20 US Cities With Large Populations, June 2, 2008, to October 31, 2008



The bar in the box represents the median; the outer edges of the box, the 25% and 75% (first and third quartiles); the whiskers, the most extreme data points no more than 1.5 times the interquartile range from the box; and the dots, outliers.The lines are placed at the average $PM_{2.5}$ (particulate matter ≤2.5 μm in aerodynamic diameter) level in Beijing before, during, and after the Olympics.[4] Data for US city pollution levels are from the National Air Pollution Monitoring Network.[7]

However, publicly reported air quality trends in Beijing during the period 1998 to 2007 may have been highly sensitive to monitoring and reporting procedures.[9] To facilitate the interpretation of air quality assessment in China, on March 1, 2012, the State Council, China's Cabinet, passed revised air quality standards and adopted an index for $PM_{2.5}$. Indices for ozone and concentrations of $PM_{2.5}$ will be included in the standards, according to a statement issued by the State Council after a meeting presided over by Premier Wen Jiaba. By 2013 the monitoring of $PM_{2.5}$ will be implemented in 113 cities on the state environmental protection list and by 2015 to all cities in China.[10]

China's dilemma, like many countries with emerging industries, is how to reconcile rapid economic growth with environmental protection. In recent decades, China has achieved industrialization and urbanization. However, China has been much less successful in maintaining the quality of urban air. Several factors challenge the implementation of air pollution controls in China: heavy reliance on coal as a main heating system, especially in subsidized housing; lack of political incentives for trading slower growth for less pollution; economic factors: most Chinese factories and power plants run on extremely thin margins and fines for pollut-

ing are generally lower than the cost of controlling emissions; and economic transformation of the landscape, from ubiquitous construction sites to the rapid expansion of the nation's vehicle fleet. If air pollution in China and other Asian nations cannot be controlled, it could spread to other continents. A recent study by Lin et al[11] provides compelling evidence that Asian emissions may account for as much as 20% of ground-level pollution in the United States.[12] Clean air is a shared global resource. It is in the common interest to maintain air quality for the promotion of global health.

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Health, Economics, and the 2012 G8 Summit

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HEALTH AND ECONOMICS ARE INEXTRICABLY LINKED. Health constitutes a vigorous sector of the economy, with effects on inflation, employment, and competitiveness. The World Health Organization estimates that health systems worldwide absorb approximately 10% of the world economy—about US $6 trillion.[1] Differences in health expenditures, however, are huge. For instance, the United States spends more than $7000 per capita on health, whereas Eritrea spends less than US $10. For low- and middle-income countries, committing more financial resources to health is a complicated and difficult decision, because most nations face many competing priorities. Nor will improving the health of the world's population be possible unless there is global economic recovery. Enlightened ministers of finance realize that better health contributes to sustainable economic growth through its effects on improved productivity.

Indeed, interest in global health has increased significantly over the past 2 decades. Modern travel and the Internet have made the world a far more intimate place, and health risks and benefits more easily travel the world. Examples of the increasing global transfer of health risks are the human immunodeficiency virus (HIV)/AIDS pandemic, the 2002-2003 severe acute respiratory syndrome outbreak, and the recent H1N1 influenza crisis. But opportunities are also spreading. Access to health care as a basic human right has been vigorously endorsed by governments and international agencies, leading to a global movement toward universal health coverage. Substantially more resources from governments and foundations have been committed to the international effort to improve the health of the world's population.[2] Numerous journals have given a powerful voice to the global health movement.[3,4] As a reflection of this increasing interest, more than 100 partnerships are now active in global health.

This global health theme issue of *JAMA*, published to coincide with the May 2012 G8 Summit in the United States, provides new information and insights directly relevant to the related issues of health, economics, and global well-being. This issue begins with 4 Viewpoints from individuals with long and rich commitments to global health. Sachs[5] provides insights about the role of economics in health care, emphasizing the

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